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Abstract

In this paper, we discuss the concept of collaborative IT infrastructure, and propose a three stage model of implementation of such infrastructure. This model is applied to a typology of projects which include three dimensions: number of sites, number of projects, and locus of project (intra versus interorganizational). We then present considerations on the successful implementation of a collaborative IT infrastructure for different types of projects. Conclusions and future research suggestions are also offered.

Introduction

Throughout the nineties, different forms of virtual projects have become more widespread, as a result of the increasing focus on globalization and organizational flexibility. Although the concept of 'virtualness' is still fraught with different meanings, a virtual project is commonly defined as involving collaboration between project members at different geographical sites, where the sites can be internationally distributed and also include different organizations (Adams and Adams, 1997). Virtual projects can also be seen as closely linked to the concept of virtual organizations. However, these two concepts should not be regarded as indistinguishable, as virtual projects can also be conducted in the context of 'traditional' organizational structures.

As argued by Marshall et al. (1999), at the heart of both virtual projects and virtual organizations are "the webs of networked microcomputers and telecommunications technologies, which facilitate real time interactivity in ways unknown more than a few years ago" (p. 484). This explicates the reliance of all virtual structures upon an IT infrastructure supporting communication, coordination and collaboration among the organizational units participating in the virtual collaboration. This infrastructure should provide universal access to the different participants in the form of synchronous and/or asynchronous communication media, necessary IT applications for working on shared information objects (e.g. documents and drawings), as well as tools for scheduling and coordination.

In several cases, the formation of a virtual project will imply a need to establish a common IT infrastructure, as this type of organizational arrangement often involves collaboration among several different organizational units in different locations potentially also comprising different organizations. However, in the literature the existence of this infrastructure is usually taken for granted, and surprisingly few have addressed the process of establishing this infrastructure. For example, Marshall et al. (1999) list the following as the 'Critical Success Factors for the virtual organization': Shared purpose, shared risk, trust, mutual benefit. We will here argue that a supporting collaborative IT infrastructure also should be regarded as a critical success factor.

The focus of this paper is on the project management aspects concerned with the implementation of a collaborative IT infrastructure for supporting virtual projects. The paper provides a general phase model for the formation of collaborative infrastructures, and applies this as a basis for discussing characteristics of this formation process in different types of virtual projects. The paper is structured as follows. First we will define the key concepts of collaborative infrastructure and IT implementation to be used in the rest of the paper. This is followed by a description of several mini-cases of issues related to the formation of collaborative infrastructures in virtual projects. Based on some of the common experiences described, we then propose a model for collaborative IT infrastructure implementation. This model is then applied to a typology of project forms, resulting in infrastructure implementation considerations for different types of projects. Finally, we provide conclusions for this work as well as future research directions.

Definition of Key Concepts

Collaborative infrastructure

The term IT infrastructure is most commonly seen as composed of hardware, software, data and telecommunications & networks, i.e. the 'physical infrastructure' (Martin, et al., 1999; Palmer, 1998). However, there are several examples of how this definition is expanded to also include other elements. Building on actor-network theory, (Monteiro and Hanseth, 1996) introduce the term 'information infrastructure' to put focus on the standardization processes that take place in the formation of institutional arrangements and new work practices evolving around the introduction of new information technologies and their alignment with the organization. And in a study on the increasing adoption of meeting schedulers in two large software organizations, (Grudin and Palen, 1995) partly ascribe this to the "pervasive supporting infrastructures" evolving in these organizations, including both technical (network, software and support) and behavioral infrastructure. The last here refers to the fact that people have become more used to incorporating technology in their work, such as e-mail.

In this paper we will apply the term 'collaborative infrastructure' to denote the various elements comprised in the infrastructure needed to support a virtual project. According to this, a collaborative infrastructure comprises hardware, telecommunication networks, software (e.g. different forms of collaboration technology, such as conferencing tools, application sharing, workflow, etc.), organizational routines for using the technology including allocation of roles and responsibilities, and finally some support apparatus offering both technical and procedural support in the application of the technology.

IT implementation

Kwon and Zmud (1987) define IT implementation as including six phases: initiation, adoption, adaptation, acceptance, use and incorporation, thus comprising the complete cycle from needs analysis to full utilisation of the technology. The focus in this paper on the implementation of a collaborative IT infrastructure, can be seen as related to the adaptation stage in this model. The adaptation stage involves the development, installation and maintenance of the IT application, and the revision and development of organizational procedures. Further, this stage also includes the training of the organizational members in the new procedures and in the IT application.

Although often used as a unified concept, the possible contextual variations create a multitude of different forms of IT implementation projects. Some of the possible different contextual dimensions are intraorganizational vs. interorganizational, single location vs. distributed, in-house vs. vendor based systems, and differences in technological scope (Fichman, 1992; Prescott and Conger, 1995). Fichman and Kemerer (1994) argue for focusing on the distinctive characteristics of the implementation context, and develop local theories for these. In this manuscript we will focus our attention on the following three dimensions, because they are at the crux of the definition of virtual projects and virtual organizations: single versus multiple locations, single versus multiple projects, and intra versus interorganizational locus.

Examples of Infrastructure Implementation In Virtual Projects

In this section, we will discuss several examples – or mini-cases – from our previous research. These examples will be the base for the model presented in the next section. These examples were chosen to discuss issues related to infrastructure implementation in distributed environments.

Establishing a Technical Infrastructure

The organizational network NNB (North-Norwegian Building Group) was formed by four independent Norwegian companies in the building industry, to compete for the contract of building the media village for the 1994 Winter Olympic Games at Lillehammer. Further expressed goals of the network were to exploit common resources and to compete on new, international markets. The process of developing tenders in this network was very resource demanding, and Telenor R&D was therefore asked to provide communication services that could support this work. They established a communication network among the different organizations in NNB, using ISDN with TCP/IP functioning as a virtual LAN. Based on this communication network, they developed a communication package offering integrated e-mail, computer-supported telephony, file sharing and fax.

The system was initially planned to be ready early in 1994, so that installation and training could take place after the first phase of the Lillehammer project was completed. However, the project ran into different technical problems, causing a delay in the implementation of nearly six months. The main reason for this problem was delays in the implementation of the ISDN services in Norway. There were also problems with limited availability of ISDN-solutions for PC, and incompatibility between the NNB virtual LAN and the existing LANs in the member organizations. By the time the technology was ready for use, the Lillehammer project was in its second peak period, involving the dismantling of the media village. The NNB organizations did not have time to introduce the technology during this period, and the installation and training therefore had to be postponed until after the completion of the Lillehammer project. At this stage, joint activity in NNB was low. The two largest companies became engaged in new projects on their own, and without new collaborative projects incentives for using the technology were lacking.

The implementation in NNB exemplifies how the process of establishing the technical infrastructure in a virtual project may not be trivial. Interoperability problems due to heterogeneous technological platforms combined with an immature stage of ISDN technology created several obstacles that had a crucial impact of the entire implementation project. The example also illustrates that before the technical infrastructure is in place, the project can not advance to the further stages of implementing collaborative software applications and developing routines for deployment of these applications.

Scheduling and Coordination

Bell Core used to be the MIS Department of the pre-breakup AT&T. It had created all the billing, invoicing and operation systems for what became the Baby Bells. Therefore, they were a natural choice for Baby Bells when any update on their systems was needed. The problem was how to generate a new version of the software that could be shipped to all Baby Bells without giving away features not paid for by the receiver or which could infringe copyrights. The solution encountered was to create a matrix structure, where project managers were assigned specific “Bells,” and therefore took ownership of the development of enhancements to the software. At the same time, there was a higher level project manager who was aware of all different features being worked on by the group as a whole. This manager avoided the likelihood of duplicate development.

Cultural Diversity and Geographical Distance Issues

Time Warner, Toshiba, and US West formed a joint venture with the objective of implementing fiber in several Japanese cities. The process consisted of American designers using a GIS to come up with a rough install plan for cable in certain Japanese neighborhoods. These maps were then shipped to Japan, where construction managers would survey the actual physical location and check for consistencies or problems. At that point, they would fix the map, send it back to Denver, where local designers would use the corrected map as a base to order the materials and equipment needed to install fiber in that Japanese neighborhood. Orders were placed to several suppliers, and then later shipped to Japan. Some of the problems included items shipped to Japan without extensive testing, and then used in situations where they failed to perform. Japanese technicians blamed Americans for the problems. Japanese technicians also made mistakes, resulting in distrust from both sides. One of the solutions encountered was for the whole team to meet face to face to iron out these problems. Although these meetings were not enough to solve all problems, we saw a resulting willingness to work more on how to solve them.

Moreover, once the structure and strong routine of design map – send to Japan – correct map – send back to US – final details worked out – was established, then the amount of actual interaction decreased a bit, and the whole project started working as an well-oiled machine. Three strong conclusions can be derived in this situation. First, that trust on a virtual environment is totally critical for the success of the project (Carmel, 1999; Jarvenpaa and Leidner, 1998). Second, that one of the best ways to create this trust is face to face encounters, although alternatives exist. Third, that even the existence of the best collaborative IT infrastructure is not sufficient in highly unstructured jobs. Conversely, as the structure increases, the availability of collaborative infrastructure improves the effectiveness of the interaction.

A Preliminary Model for Collaborative Infrastructure Implementation in virtual Projects

A Stage Model of Collaborate Infrastructure Implementation

Based on the mini-cases described in the previous section, we can now propose a phase model of collaborative infrastructure implementation. The situation described in the NNB suggests that the first concern is to have the technical infrastructure totally implemented and tested before any project, virtual or otherwise, is attempted. We will call that the first stage, and propose that most issues are related to hardware.

The second stage is related to software readiness, as evidenced by installation, testing, and final availability to users. The problems we found in this stage mostly relate to the fact that many times people tend to appropriate different uses to the software than originally intended by designers. Therefore, the outcomes might not be exactly what was planned. Also, when users try to use a particular feature that was "advertised" by the analysts and find out that this particular feature is not available or works in a different way than intended, they may not want to come back to try it again.

Finally, the third stage relates to available guidelines. Quite possibly, this may be where most of the differences between traditional and virtual projects are. For instance, let us assume that beginners in distributed projects may tackle something like a distributed text writing project. Relatively simple decisions such as who is holding the "editable" version and who can use it as read-only (basically, concurrent update issues) need to be made explicit. Such problems disappear when people start using software with versioning control to work on their distributed project, but this typically only happens when a decision is made to move toward that type of environment. In fact, it is interesting how many basic issues are missed because people are trying a distributed environment for the first time. For instance, Suleiman et al. (forthcoming) suggest that a well defined task and deadline description may increase the chances that people may establish a good rapport across locations. Similarly, they suggest that some of these simple rules may include: only one question per email, absence of totally open-ended questions, at least at the beginning of the exchanges, and that the existence of a project manager or facilitator is also relevant.

So, how do we achieve a collaborative infrastructure implementation in virtual projects? Our model will be implemented differently depending on the type of virtual project we are describing. In the next section, we will discuss a typology of projects, and will then base our argument for the different types of implementation on it.

A Typology of Collaborative Projects

Figure 1 presents a general typology of projects (Evaristo and Fenema, 1999), with number of geographical locations and number of projects as the key dimensions.

A simple view of figure 1 suggests that as many as 7 different types of projects exist. When applied in the context of virtual projects, we also have to include the dimension of intra versus interorganizational projects, thus expanding the typology to 14 project types. In practice, some of these combinations are unlikely, such as the single project, single location situation, which is not that likely to be interorganizational. But the fact remains nonetheless that there are many possible combinations.

We will apply this typology as a basis for our discussion of collaborative infrastructure formation in different types of virtual projects. We lack space to discuss each of the possible combinations in the typology. Instead, we choose to focus on the following situations: traditional projects (single project, single location,), distributed project (single project, multiple locations) and multiple distributed projects (multiple projects, multiple locations). The first of these represents the most simple project form in Figure 1.

Most of the empirical research on IT implementation actually focuses on this type of project. Thus, the

traditional project is included here to enable comparison with other more complex project forms. The distributed project can be seen as a general representation of the most common form of virtual projects, i.e. that which includes a single project in different locations. Examples A and C in the previous section both fall into this category. The third type of project, i.e. multiple distributed projects represents the most complex form. Example B represents an instance of this type of project. In the following, characteristics of these three types of projects will be discussed and related to the three phases of collaborative infrastructure implementation defined earlier.

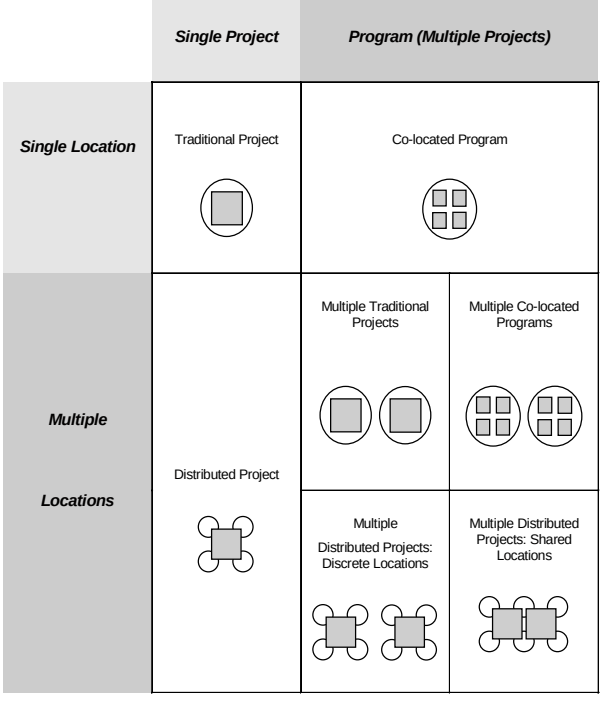

Fig. 1. Project Typology (Adapted from Evaristo and Fenema, 1999)

Where:

= Project

= Location

Infrastructure implementation in traditional projects

It can be argued that the traditional project category in Figure 1 does not apply to virtual projects, as the collaboration here takes place in a single location. Single location is here defined as involving a distance between project stakeholders that is considered by them as having the project co-located (Evaristo and Fenema, 1999). In fact, studies have shown that distance between offices in the same building may actually represent a barrier to face-to face collaboration (Kraut et al., 1990), thus resulting in the preference of other communications media such as phone or e-mail. However, even co-located projects may benefit from collaborative technologies, as it is the case in electronic meeting rooms.

It is also common that much of the project work in a single organization may take place in an asynchronous mode, using e-mail and other types of communication tools. Further, technologies for supporting coordination (e.g. workflow management and calendaring and scheduling) and information sharing (e.g. document management systems and knowledge repositories) are increasingly being implemented for supporting intraorganizational project work conducted in single locations.

The three-phase model of collaborative infrastructure implementation presented earlier suggests that traditional projects are characterized by the following. Similar to all types of projects, the technical infrastructure needs to be in place and operational before the following two stages can be realized. The degree of variation in the existing infrastructure in the organization will depend on whether the organization has developed and implemented an IT strategy or whether investments and technical upgrades are made more on an *ad hoc* basis. In any case, the existing technical infrastructure will normally be more homogeneous than in a distributed project. Further, the activities related to acquiring and installing new hardware are relatively easy to manage when conducted in a single project in a single organization.

The same arguments apply for the second stage, or the implementation of collaborative applications in the project. Planning and scheduling of the activities related to installation, testing, integration with existing software, and training of users will normally be of a relatively low complexity. For example, all users can be trained at the same location, and as the users will share much of the same background, culture and experience the need for adapting the training to different users is not great.

Stage three in the process of collaborative infrastructure formation involves the specification of organizational routines and guidelines for effective use of the technology. Studies of the implementation of different forms of collaboration technology have identified several potential barriers in this process (Bowers, 1994; Ciborra, 1996; Munkvold, 1999; Orlikowski, 1992). The flexible nature of collaboration technologies like Lotus Notes may result in that the users develop different mental models of the technologies, resulting in inefficient use. Further, the implementation of collaborative applications will often result in that tacit organizational practices are made explicit, such as in the case of workflow technologies, and may also require new work practices where people are expected to share information openly even though it is not considered complete. This implies a transparency in the work processes that may feel uncomfortable to users. All together, these studies show that the need for developing guidelines for effective use of collaboration technology is great, even in a traditional project situation. Although this may be a challenging task, the definition and implementation of these routines will be easier to manage in a traditional project than in a distributed one. For example, a decision to change work procedures and introduce new mandatory guidelines is less problematic in the context of a single organizational structure than in a

project possibly comprising several independent decision-structures with varying incentive systems and work cultures. Further, in a traditional project there will at any time be possible to resolve any conflicts or ambiguity through face-to-face communication.

This situation changes when there are more projects, locations, organizations, or a combination of these elements. In the next two sections, we will discuss this more complex situation.

Infrastructure implementation in distributed projects

The distributed project form comprises a single project conducted in multiple geographical locations. Thus, compared to infrastructure implementation in traditional projects the management of this type of project requires inter-site coordination or boundary spanning across the multiple sites (Evaristo and Fenema, 1999). The organization of the implementation project will typically involve representatives from the IT units of the different sites, where these exist. However, there will usually be established a core IT implementation team that has the overall responsibility and mandate to conduct the different project activities (Munkvold, 1999). The staffing of this team may be subject of negotiation among the participating units. Another dimension that distinguishes IT implementation in virtual projects from traditional IT implementation is the time frame for this organizational arrangement. By definition, a virtual project is temporary in nature, being established to exploit a specific business opportunity and then being dissolved when the project is completed (Palmer, 1998). There are key differences from traditional implementation in all three stages. In the first stage, the technical infrastructure now has to accommodate (a) telecommunications capabilities – typically internet connection, but maybe other alternatives as well, and (b) appropriate translation mechanisms across potentially different platforms across different organizations. As exemplified in the NNB project, heterogeneous technological platforms in the different locations may create problems with interoperability. This may imply a need for conducting extensive tests of different combinations of hardware and network technologies prior to installation and use.

In the second stage, collaborative software to help the stakeholders work in geographically distributed locations should be made available. As in the first stage, testing here is more complex compared to in traditional projects, because many possibilities and combinations have to be anticipated and checked. For example, in cases where new collaborative applications need to be implemented, it is important that these also can be integrated with the application portfolio currently in use at each site. In general, the geographical dispersion in these projects creates logistical challenges related to installation, testing, training and support at each site. Training here also needs to be adapted to the background and former experience of the users at each site.

The third stage is now particularly crucial. Guidelines on how the projects should be conducted need to exist, as well as appropriate tools to help manage these projects. This also involves the allocation of roles and responsibilities related to the information handling in the project. In cases where the virtual project involves interorganizational collaboration, effective use of the technology will be dependent on that a level of trust is established among the participants. The development and negotiation of organizational routines can also be further complicated by cultural differences among the different sites, as illustrated in example C.

Infrastructure implementation in multiple distributed projects

Our most complex collaborative project involves (a) many projects, (b) each of which can be worked from many locations, (c) and with stakeholders that can belong to different organizations. We also have interdependencies and resources shared across these projects and locations. These collaborative projects are also "distributed" in other ways then purely geographical (e.g., dimensions of "distributedness" such as synchronicity, culture, structure, and the existence of policies and standards (Evaristo and Scudder, 2000)). Actually, the other project forms in Figure 1 can be adapted from this one by relaxing one or more constraints.

The crucial difference of interdependencies (as compared to previous models) creates special needs for the collaborative infrastructure. Knowledge sharing involves making available selected information across different projects to appropriate stakeholders. It should, in addition, involve prioritization schemes, cross-site and cross-project calendaring and other project management tools such as Gantt charts. In the Bell Core example, the different project managers had to be informed on the status of the projects which interacted with theirs on a need to know basis (knowledge sharing). The higher level project managers, on the other hand, were involved in several projects located in different cities. It was extremely important for them to be able to prioritize their efforts across those commitments.

Conclusion and Implications

In this manuscript, we have presented a stage model of collaborative infrastructure implementation and then applied it to a categorization of collaborative project types. The result of this exercise pointed out critical differences which exist in the implementation of collaborative infrastructure between traditional projects, distributed projects and multiple distributed projects.

Future research may develop more fully the nature of how our stage model interacts with the different cells in our project typology and empirically test predictions afforded in the model.

From a practitioner's perspective, we know that most of the project management techniques existing today stem from the traditional single project, single location situation. The current manuscript extends this situation and proposes that in complex collaborative projects more guidelines for stakeholder interaction need to be developed. In addition, it suggests that project management tools appropriate for these types of projects need to be developed and implemented.

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